38. (New) The method of claim 36, wherein the noble metal is platinum, iridium, or ruthenium.

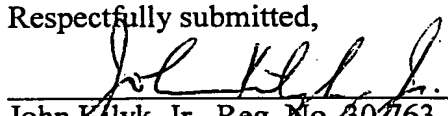
39. (New) The method of claim 38, wherein the polishing additive is selected from the group consisting of oxalate salts, pyrophosphate salts, aminotri(methylenephosphonic acid), 1-diphosphonic acid, diethylenetriaminepenta(methylenephosphonic acid), amino acids, and thiodiacetic acid.

REMARKS

The paragraphs and tables set forth above from the specification have been amended to correct typographical errors. Newly added claims 32-34 are directed to a method of polishing a substrate comprising iminodiacetic acid. Support for the new claims can be found in the specification at page 6, lines 17-20, page 7, lines 33-34, and the originally filed claims (e.g., claims 22 and 23). Newly added claim 35 recites the system of claim 22, further comprising ammonia or an ammonium salt. Support for new claim 35 can be found in the specification at page 11, lines 22-23. Newly added claims 36-39 are directed to a method of polishing a substrate comprising a noble metal. Support for the new claims can be found in the specification at page 4, lines 3-10, and page 5, line 4, through page 7, line 32. No new matter has been added by way of these amendments. For the convenience of the Examiner, the precise changes to the specification and claims, as well as a complete set of pending claims, as amended, are set forth on separate attachments thereto.

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If in the opinion of the Examiner a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,



John Kilyk, Jr., Reg. No. 30,763
One of the Attorneys for Applicant(s)
LEYDIG, VOIT & MAYER, LTD.
Two Prudential Plaza, Suite 4900
180 North Stetson
Chicago, Illinois 60601-6780
(312) 616-5600 (telephone)
(312) 616-5700 (facsimile)

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PATENT
Attorney Docket No. 98124x205487

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Wang et al.

Application No. 09/636,161

Filed: August 10, 2000

For: POLISHING SYSTEM AND METHOD OF ITS USE

Group Art Unit: 1765

Examiner: L. Umez-Eronini

PRELIMINARY AMENDMENTS TO SPECIFICATION AND CLAIMS

(deletions indicated by crossed-out text; additions indicated by underlined text)

Amendments to the paragraph beginning at page 1, line 13:

Integrated circuits are made up of millions of active devices formed in or on a substrate, such as a silicon wafer. The active devices are chemically and physically connected into a substrate and are interconnected through the use of multilevel interconnects to form functional circuits. Typical multilevel interconnects comprise a first metal layer, an interlevel dielectric layer, and sometimes a third and subsequent metal layer. Interlevel dielectrics, such as doped and undoped silicon dioxide (SiO_2) and/or low-κ ~~dielectrics are~~ dielectrics, are used to electrically isolate the different metal layers.

Amendments to the paragraph beginning at page 5, line 11:

The polishing additive can be any suitable phosphorous-containing compound. Suitable phosphorous-containing compounds include, for example, phosphates (e.g., pyrophosphates, tri-phosphates, condensed phosphates), phosphonic acids (e.g., mono-phosphonic acids, di-phosphonic acids, tri-phosphonic acids, poly-phosphonic acids), and salts of phosphonic acids. Preferred phosphorous-containing compounds include, for example, pyrophosphates, phosphonoacetic acid, ethylene ~~di-phosphonic~~ diphosphonic acid, ~~1-hydroxyethylidene-1,1-di-phosphonic~~ 1-hydroxyethylidene-1,1-diphosphonic acid, and mixtures thereof. Preferred phosphorous-containing compounds also include, for example, $M_n^{+1}H_{3-n}PO_4$ and $M_m^{+1}H_{4-m}P_2O_7$, wherein M^{+1} is a cationic species (e.g., Na, K, Cs, Rb, NH_4^+), ~~n= 0-3~~ n = 0-3, and m = 0-4. Moreover, a preferred phosphorous-containing compound is R-O-PO_3, wherein R is an organic moiety selected from the group consisting of alkyl, aryl, cyclic, and aromatic groups having from 1-18 carbon atoms.

Amendments to the paragraph beginning at page 5, line 30:

Preferably, at least one polishing additive comprises the structure ~~XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y'~~ XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y', wherein X, Y, X', Y', R^1, R^2, R^3, and R^4 are ~~selected from~~ selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof. More preferably, at least one polishing additive comprises the structure ~~XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y'~~ XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y', wherein X and X' are H atoms, and wherein Y, Y', R^1, R^2, R^3, and R^4 are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic ~~groups, aromatic~~ groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof. Even more preferably, at least one polishing additive comprises the structure ~~XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y'~~ XY-NCR^{1}R^{2}CR^{3}R^{4}N-X'Y', wherein X, Y, X', and Y' are H atoms, and wherein R^1, R^2, R^3, and R^4 are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof. In this regard, nitrogen-containing compounds that consist of primary amine groups are preferred over nitrogen-containing compounds that comprise secondary amine groups and/or tertiary amine groups, alone or in combination with primary amine groups. Moreover, it is suitable for at least one polishing additive to comprise the structure as described above, wherein the structure is in the form of a polymer comprising about four or more (e.g., about 10 or more, about 15 or more, about 20 or more, about 30 or more, about 40 or more, or even about 50 or more) dissimilar, similar, or even identical adjoined structures. Most preferably, the nitrogen-containing compound is selected from the group consisting of polyethylenimine, 1,3-diamino-2-propanol, ~~imino-di-acetic acid~~ imino-diacetic acid, 2-amino-1-butanol, ethylenediamine, aminoethylethanolamine, ~~2,2'-aminoethoxy-ethanol~~ 2,2'-aminoethoxyethanol, and mixtures thereof.

Amendments to the paragraph beginning at page 7, line 10:

Suitable polishing additives also include one or more compounds selected from the group consisting of (i) compounds that are both phosphorous-containing compounds and nitrogen-containing compounds, (ii) compounds that are both phosphorous-containing compounds and sulfur-containing compounds, (iii) compounds that are both nitrogen-containing compounds and sulfur-containing compounds, and (iv) compounds that are phosphorous-containing compounds, nitrogen containing compounds, and sulfur-containing compounds. Preferred polishing additives include, for example, compounds selected from the group consisting of ~~2-aminoethyl phosphonic~~ 2-aminoethylphosphonic acid,

amino(trimethylenephosphonic acid), ~~diethylenetriaminepenta(methylene phosphonic acid)~~ diethylenetriaminepenta(methylenephosphonic acid), ~~hexamethylenediamine tetra(methylene phosphonic acid)~~ hexamethylenediaminetetra(methylenephosphonic acid), and mixtures thereof. Moreover, preferred polishing additives include, for example, phosphonic compounds containing primary, secondary and/or tertiary amines, such as, for example, ~~N-(phosphonomethyl) iminodiacetic acid~~ N-(phosphonomethyl)iminodiacetic acid, 2-aminoethyl dihydrogen phosphate, ~~2-aminoethyl phosphonic acid~~ 2-aminoethylphosphonic acid, ~~2-aminoethyl phosphonic acid~~ 2-aminoethylphosphonic acid, aminotri(methylenephosphonic acid) (i.e., Dequest® 2000 product), ~~1-hydroxyethylidene-1, 1-di phosphonic acid~~ 1-hydroxyethylidene-1,1-diphosphonic acid (i.e., Dequest® 2010 product), and ~~diethylenetri-aminepenta(methylenephosphonic acid)~~ diethylenetriaminepenta(methylenephosphonic acid) (i.e., Dequest® 2060 product).

Amendments to the paragraph beginning at page 8, line 9:

The stopping compound can be any suitable cationically charged nitrogen-containing compound selected from the group of compounds comprising amines, imines, amides, imides, polymers thereof, and mixtures thereof. The term "cationically charged" as used herein means that a portion (e.g., about 5% or more, about 10% or more, about 15% or more, or about 20% or more) of the stopping compound in the liquid portion of the system is in cationic form at the operating pH of the system of the present invention. Preferably, the stopping compound has a pKa value that is 1 or more units greater than the operating pH of the liquid portion of the system. For example, in a system with a pH of 6.5, preferred stopping compounds would have a pKa value of about 7.5 or more. Preferred stopping compounds also are oppositely charged from the surface charge of the second layer of the substrate layer. Suitable stopping compounds include, for example, compounds comprising primary amines, secondary amines, tertiary amines, quaternary amines (i.e., quaternary ammonium salts), etheramines, oligomeric amines, oligomeric imines, oligomeric amides, oligomeric imides, polymeric amines, polymeric imines, polymeric amides, polymeric imides, or mixtures thereof. Moreover, suitable stopping compounds include, for example, amino acids, amino alcohols, amino ether alcohols, or mixtures thereof. Preferred stopping compounds also include, for example, polyetheramines, polyethylenimines, ~~N_4-amino (N,N'-bis-[3-aminopropyl]ethylene diamine)~~ N_4-amino(N,N'-bis-[3-aminopropyl]ethylenediamine), 4,7,10-trioxatridecane-1,13-diamine, ~~3,3-dimethyl-4,4-diaminodicyclo-hexylmethane~~ 3,3-dimethyl-4,4-diaminodicyclohexylmethane, 2-phenylethylamine, ~~N,N-dimethyldi-propylenetriamine~~ N,N-dimethyldipropylenetriamine, 3-[2-methoxyethoxy]propylamine, dimethylaminopropylamine, ~~1,4-bis(3-aminopropyl) piperazine~~ 1,4-bis(3-aminopropyl)piperazine, and mixtures thereof. In addition, preferred stopping compounds include, for example, isophorone diamine, hexamethylenediamine, ~~cyclohexyl-1,3-~~

~~propane diamine~~ cyclohexyl-1,3-propanediamine, thiomicamine, ~~(aminopropyl)-1,3-propane-diamine~~ (aminopropyl)-1,3-propanediamine, ~~tetraethylene pentamine~~ tetraethylenepentamine, tetramethylbutanediamine, propylamine, diaminopropanol, aminobutanol, (2-aminoethoxy)ethanol, or mixtures thereof.

Amendments to the paragraph beginning at page 9, line 5:

The system of the present invention can comprise any suitable combination of at least one polishing additive and at least one stopping compound. For example, the system can comprise polyethylenimine and at least one polishing additive selected from the group consisting of a carboxylic acid (preferably, a di-, tri-, or poly-carboxylic acid), a phosphate (preferably, a pyrophosphate, a tri-phosphate, or a condensed phosphate), an acid thereof, and a phosphonic acid (preferably, a di-, tri-, or poly-phosphonic acid). The system also can comprise at least one polishing additive selected from the group consisting of a carboxylic acid (preferably, a di-, tri-, or poly-carboxylic acid), a phosphate (preferably, a pyrophosphate, a tri-phosphate, or a condensed phosphate), an acid thereof, and a phosphonic acid (preferably, a di-, tri-, or poly-phosphonic acid) and at least one stopping compound comprising two or more, three or more, four or more, five or more, or even six or more nitrogen atoms (e.g., at least one stopping compound comprising two or more amine groups, at least one stopping compound comprising two or more primary amine groups, at least one stopping compound comprising two or more amino groups and 4 or more carbon atoms, or at least one stopping compound comprising two or more primary amine groups containing 3 or more carbon atoms). Moreover, the system can comprise at least one polishing additive selected from the group consisting of a carboxylic acid (preferably, a di-, tri-, or poly-carboxylic acid), a phosphate (preferably, a pyrophosphate, a tri-phosphate, or a condensed phosphate), an acid thereof, and a phosphonic acid (preferably, a di-, tri-, or poly-phosphonic acid) and a quaternary ammonium salt comprising the structure $NR^1R^2R^3R^4$, wherein R^1, and R^2 are methyl groups and R^3 and R^4 are selected from the group consisting of ~~of~~ hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof. In addition, the system can comprise at least one polishing additive selected from the group consisting of a carboxylic acid (preferably, a di-, tri-, or poly-carboxylic acid), a phosphate ~~acid~~(preferably, a pyrophosphate, a tri-phosphate, or a condensed phosphate), an acid thereof, and a phosphonic acid (preferably, a di-, tri-, or poly-phosphonic acid) and at least one stopping compound comprising an aminopropyl group and/or at least one stopping compound having a molecular weight (MW) of about 80 or more (e.g., a MW of about 100 or more, a MW of about 250 or more). Furthermore, the system can comprise a peroxide, aminotri(methylenephosphonic acid), and ~~1, 4-bis(3-amino propyl)-piperazine~~ 1,4-bis(3-aminopropyl)piperazine, and optionally, at least one passivation film

forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings. The system also can comprise a peroxide, tartaric acid, and a polyethylenimine, and, optionally, at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings.

Amendments to the paragraph beginning at page 11, line 22:

The system of the present invention further can comprise a source of ammonia (e.g., ammonia or an ammonium salt). Ammonia and/or ammonium salts enhance the removal rate and/or removal selectivity (e.g., Cu:Ta removal selectivity) of the system, by interacting with one or more components of the system (e.g., the polishing additive). Preferably, the system of the present invention comprises ammonia and/or ammonium salts and one or more polishing additives. Preferably, the system comprises a source of ammonia and at least one polishing additive selected from the group consisting of a carboxylic acid (preferably, a di-, tri-, or poly-carboxylic acid), a phosphate (preferably, a pyrophosphate, a tri-phosphate, or a condensed phosphate), an acid thereof, and a phosphonic acid (preferably, a di-, tri-, or poly-phosphonic acid). For example, the system can comprise ~~aminotri(methylene-phosphonic acid)~~ aminotri(methylenephosphonic acid) and a source of ammonia (e.g., ammonia and/or an ammonium salt).

Amendments to the paragraph beginning at page 11, line 34:

Suitable polymeric compounds include, for example, any suitable polymeric compound that reduces the polishing rate of at least one layer associated with the substrate. Preferably, the system comprises at least one polymeric compound comprising a polyvinylalcohol, a polyethylene oxide, a polypropylene oxide, a sulfonic acid polymer, a sulfonate polymer, or a mixture thereof.

Amendments to the paragraph beginning at page 16, line 14:

These results demonstrate the significance a polishing additive comprising the ~~XY-NCR2CR2N-X'Y'~~ XY-NCR$_2$CR$_2$N-X'Y' moiety in the context of the present inventive system, as well as the significance of the ratio of primary:secondary:tertiary amino groups in the ~~XY-NCR2CR2N-X'Y'~~ XY-NCR$_2$CR$_2$N-X'Y' moiety of the polishing additive, on the polishing rate achievable by the present inventive system and method.

Amendments to the paragraph beginning at page 16, line 24:

Copper wafers and tantalum wafers were polished separately with sixteen different polishing systems (designated Systems 3A-3P) with 3 wt.% alumina (specifically, Cabot's Semi-Sperse® W-A355 product), 2.5 wt.% oxidizing agent (specifically, H_2O_2), and either 0.5 wt.% or 1 wt.% of a polishing additive (specifically, ~~1-di-phosphonic acid~~ 1-diphosphonic acid (i.e., Dequest® 2010 product), ~~diethylenetriaminepenta-(methylenephosphonic acid)~~

diethylenetriaminepenta(methylenephosphonic acid) (i.e., Dequest® 2060 product), ~~N-phosphono-methyliminodiacetic acid~~ N-phosphonomethyliminodiacetic acid, Lupasol® FG, 1,3-diamino-2-propanol, 2-imino-4-thiobiuret, iminodiacetic acid, ~~dimethylgloxime~~ dimethylglyoxime, ~~dipyridine amine~~ dipyridylamine, iminodiacetonitrile, guanidine nitrate, ~~pyrazine carbonitrile~~ pyrazinecarbonitrile, thioglycolic(mercaptoacetic)acid, thiodipropanionic acid, 1 wt.% of ~~an a ethoxylated~~ an ethoxylated high molecular weight ~~polyethylimine~~ polyethylenimine (i.e., Lupasol® SC-61B), or a modified high molecular weight ethylenimine polymer (i.e., Lupasol® SKA)), wherein each of the systems had a pH of 5 (Systems 3C, 3F, 3H, 3I, 3K, 3L, 3O, and 3P) or a pH of 7.7 (Systems 3A, 3B, 3D, 3F, 3G, 3J, 3M, and 3N).

Amendments to Table 3 beginning at page 17, line 5:

Following use of the systems, the removal rate (RR) of copper and tantalum by each system was determined, as well as the relative removal of copper to tantalum ("Cu:Ta"). The resulting data are set forth in Table 3.

Table 3:

System	Polishing Additive	Cu RR [Å/min]	Ta RR [Å/min]	Cu:Ta
Control	none	87	198	1:2
3A	1 wt.% Dequest® 2010	4777	406	12:1
3B	1 wt.% Dequest® 2060	7624	279	27:1
3C	1 wt.% N-phosphonomethyl-iminodiacetic acid	4333	314	14:1
3D	1 wt.% Lupasol® FG	733	13	56:1
3E	1 wt.% 1,3-diamino-2-propanol	2668	50	53:1
3F	1 wt.% 2-imino-4-thiobiuret	1216	95	13:1
3G	1 wt.% iminodiacetic acid	7738	533	15:1
3H	0.5 wt.% ~~dimethylgloxime~~ dimethylglyoxime	1153	273	4:1
3I	0.5 wt.% ~~dipyridine amine~~ dipyridylamine	3022	264	11:1
3J	1 wt.% iminodiacetonitrile	243	446	1:1.8
3K	0.5 wt.% guanidine nitrate	281	289	1:1
3L	0.5 wt.% ~~pyrazine carbonitrile~~ pyrazinecarbonitrile	246	323	1:1.3

3M	1 wt.% thioglycolic(mercaptoacetic) acid	552	263	2:1
3N	1 wt.% thiodipropanionic acid	652	250	2.6:1
3O	1 wt.% Lupasol® SC-61B	682	14	49:1
3P	0.5 wt.% Lupasol® SKA	480	15	32:1

Amendments to the paragraph beginning at page 19, line 18:

Copper wafers, tantalum wafers, and silicon dioxide (SiO_2) wafers were polished separately with eight different polishing systems (designated Systems 5A-5G) with 3 wt.% alumina (specifically, Cabot's Semi-Sperse® W-A355 product), 2.5 wt.% oxidizing agent (specifically, H_2O_2), varying concentrations of a polishing additive (specifically, 1.25 wt.% tartaric acid, 0.5 wt.% 1-di[-]phosphonic acid (i.e., Dequest® 2010 product), 0.75 wt.% aminotri(methylenephosphonic acid) (i.e., Dequest® 2000 product), 0.8 wt.% Dequest® 2010 product, or 2.5 wt.% Dequest® 2000 product), and varying concentrations of a stopping compound (specifically, 0.25 wt.% Lupasol® SKA, which contains 25% of an ethylenimine polymer (i.e., 0.06 wt.% polyethylenimine), 0.1 wt.% dicyanoimidazole, 0.5 wt.% Lupasol SKA (i.e., 0.12 wt.% polyethylenimine), 0.5 wt.% polyacylamide, or 0.5 wt.% 1,4-bis(3-aminopropyl) piperazine, or 0.5 wt.% Varisoft® 300, which contains ~~cetyl trimethyl ammonium chloride)~~ cetyl trimethylammonium chloride, wherein each of the systems had a pH of 5 (System 5E) or a pH of 7.7 (Systems 5A-5D, 5F-5G). Moreover, System 5C contained 0.005 wt.% surfactant (specifically, Triton DF-16).

Amendments to the paragraph beginning at page 24, line 5:

Copper wafers, tantalum wafers, and silicon dioxide (SiO_2) wafers were polished separately with fourteen different polishing compositions with 3 wt.% alumina (specifically, Cabot's Semi-Sperse® W-A355 product), 2.5 wt.% oxidizing agent (specifically, H_2O_2), 1 wt.% polishing additive (specifically, ammonium oxalate ($(NH_4)_2C_2O_4$)), and varying concentrations of a stopping compound (specifically, 0.2 wt.% ~~isophorone diamine~~ isophoronediamine, 0.2 wt.% ~~hexamethylene diamine~~ hexamethylenediamine, 0.2 wt.% ~~N-cyclohexyl-1,3-propane diamine~~ N-cyclohexyl-1,3-propanediamine, 0.2 wt.% ~~N-(3-aminopropyl)-1,3-propane diamine~~ N-(3-aminopropyl)-1,3-propanediamine, 0.2 wt.% tetraethylenepentamine, 0.2 wt.% N,N,N',N'-tetramethyl-1,4-butanediamine, 0.5 wt.% propylamine, 0.2 wt.% 2-(2-aminoethoxy)ethanol, 2.0 wt.% 1,3-diamino-2-propanol, 1.0 wt.% thiomicamine, 3.0 wt.% 2-amino-1-butanol, 0.2 wt.% 4,7,10-trioxa-1,13-tridecanediamine, 0.2 wt.% lysine, 0.2 wt.% ~~poly[bis(2-chloroether)-alt-1,3-bis(3-dimethylamino)propyl])~~ poly[bis(2-chloroether)-*alt*-1,3-bis(3-dimethylamino)propyl], wherein each of the systems had a pH of 7.6. For comparison purposes, the test wafers also were polished with a control system ("control") with 3 wt.% alumina (specifically, Cabot's Semi-Sperse® W-A355

product), 2.5 wt.% oxidizing agent (specifically, H_2O_2), and 1 wt.% polishing additive (specifically, ammonium oxalate $(NH_4)_2C_2O_4$), wherein the control system had a pH of 7.6. Following use of the polishing compositions, the relative tantalum (Ta) removal rate and the relative silicon dioxide (SiO_2) removal rate of each system were determined in comparison with the removal rates of the control system, with the resulting data set forth in Table 7.

Table 7:

System	Stopping Compound	Relative Removal Rate Ta	Relative Removal Rate SiO_2
Control	None	1	1
7A	0.2 wt.% ~~isophorone diamine~~ isophoronediamine	0.17	-
7B	0.2 wt.% hexamethylenediamine	0.24	0.27
7C	0.2 wt.% ~~N-cyclohexyl-1,3-propane diamine)~~ N-cyclohexyl-1,3-propanediamine	0.12	0.11
7D	0.2 wt.% ~~N-(3-aminopropyl)-1,3-propane diamine~~ N-(3-aminopropyl)-1,3-propanediamine	0.17	0.03
7E	0.2 wt.% tetraethylenepentamine	0.21	0.13
7F	0.2 wt.% N,N,N',N'-tetramethyl-1,4-butanediamine	-	0.37
7G	0.5 wt.% propylamine	0.17	-
7H	0.2 wt.% ~~2-(2-aminoethoxy) ethanol~~ 2-(2-aminoethoxy)ethanol	0.71	-
7I	3.0 wt.% 2-amino-1-butanol	0.04	0.21
7J	0.2 wt.% 4,7,10-trioxa-1,13-tridecanediamine	0.28	0.22
7K	0.2 wt.% lysine	0.35	1.1
7L	0.2 wt.% ~~poly[bis(2-chloroether)-alt-1,3-bis(3-dimethylamino)-propyl]~~ poly[bis(2-chloroether)-*alt*-1,3-bis(3-dimethylamino) propyl]	-	0.33

The following claims are added:

32. (New) The system of claim 1, wherein at least one polishing additive is iminodiacetic acid.

33. (New) The system of claim 32, wherein the system further comprises at least one stopping compound.

34. (New) The system of claim 32, wherein the system further comprises at least one polymeric compound that reduces the polishing rate of at least one layer associated with the substrate.

35. (New) The system of claim 22, wherein the system further comprises ammonia or an ammonium salt.

36. (New) A method of polishing one or more layers of a multi-layer substrate that includes a first noble metal layer and a second layer comprising:

(i) contacting the substrate with a chemical-mechanical polishing system comprising:

(a) a liquid carrier,

(b) at least one oxidizing agent,

(c) at least one polishing additive that increases the rate at which the system polishes the noble metal layer of the substrate, wherein the polishing additive is selected from the group consisting of carboxylates and acids thereof, hydroxylates and acids thereof, carbonylates and acids thereof, pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, amines, amino alcohols, amides, imines, imino acids and salts thereof, nitriles, nitros, thiols, thioesters, thioethers, carbothiolic acids and salts thereof, carbothionic acids and salts thereof, thiocarboxylic acids and salts thereof, sulfonic acids and salts thereof, thiosalicylic acids and salts thereof, and mixtures thereof, and

(d) a polishing pad and/or an abrasive, and

(ii) abrading at least a portion of the substrate to polish the substrate.

37. (New) The method of claim 36, wherein the oxidizing agent is a per-compound.

38. (New) The method of claim 36, wherein the noble metal is platinum, iridium, or ruthenium.

39. (New) The method of claim 38, wherein the polishing additive is selected from the group consisting of oxalate salts, pyrophosphate salts, aminotri(methylenephosphonic acid), 1-diphosphonic acid, diethylenetriaminepenta(methylenephosphonic acid), amino acids, and thiodiacetic acid.

PATENT
Attorney Docket No. 98124x205487

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Wang et al.

Application No. 09/636,161

Filed: August 10, 2000

Group Art Unit: 1765

Examiner: L. Umez-Eronini

For: POLISHING SYSTEM AND METHOD OF ITS USE

PENDING CLAIMS AFTER PRELIMINARY AMENDMENT DATED JANUARY 17, 2002

1. A system for polishing one or more layers of a multi-layer substrate that includes a first metal layer and a second layer comprising (i) a liquid carrier, (ii) at least one oxidizing agent, (iii) at least one polishing additive that increases the rate at which the system polishes at least one layer of the substrate, wherein the polishing additive is selected from the group consisting of pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, amines, amino alcohols, amides, imines, imino acids, nitriles, nitros, thiols, thioesters, thioethers, carbothiolic acids, carbothionic acids, thiocarboxylic acids, thiosalicylic acids, and mixtures thereof, and (iv) a polishing pad and/or an abrasive.

2. The system of claim 1, wherein the liquid carrier is a nonaqueous solvent.

3. The system of claim 1, wherein the liquid carrier is water.

4. The system of claim 3, wherein the system comprises an abrasive suspended in the liquid carrier.

5. The system of claim 3, wherein the abrasive is fixed on the polishing pad.

6. The system of claim 3, wherein no abrasive is present in the system, and the polishing pad is a non-abrasive pad.

7. The system of claim 3, wherein at least one polishing additive is selected from the group consisting of di-phosphonic acids, tri-phosphonic acids, poly-phosphonic acids, phosphonoacetic acids, and mixtures thereof.

8. The system of claim 7, wherein at least one oxidizing agent is a peroxide, and wherein the system further comprises at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings.

9. The system of claim 7, wherein at least one polishing additive is selected from the group consisting of ethylene di-phosphonic acid, 1-hydroxyethylidene-1,1-di-phosphonic acid, and a mixture thereof.

10. The system of claim 3, wherein at least one polishing additive is selected from the group consisting of primary amines, secondary amines, tertiary amines, hydroxylated amines, and mixtures thereof.

11. The system of claim 10, wherein at least one polishing additive comprises the structure XY- $NCR^1R^2CR^3R^4N$-X'Y', wherein X, Y, X', Y', R^1, R^2, R^3, and R^4 are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, C_1-C_{20} alkyl groups, heteroatom-containing C_1-C_{20} alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

12. The system of claim 11, wherein at least one polishing additive comprises the structure XY- $NCR_1R_2CR_3R_4N$-X'Y', wherein X and X' are H atoms, and wherein Y, Y', R^1, R^2, R^3, and R^4 are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

13. The system of claim 12, wherein at least one polishing additive comprises the structure XY- $NCR^1R^2CR^3R^4N$-X'Y', wherein X, Y, X', and Y' are H atoms, and wherein R^1, R^2, R^3, and R^4 are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

14. The system of claim 11, wherein at least one polishing additive is selected from the group consisting of aminoethylethanolamine, polyethyleneimine, and a mixture thereof.

15. The system of claim 12, wherein at least one polishing additive is ethylenediamine.

16. The system of claim 13, wherein at least one oxidizing agent is a peroxide, and wherein the system further comprises at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings.

17. The system of claim 3, wherein at least one polishing additive is both (a) a compound selected from the group consisting of pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, and (b) a compound selected from the group consisting of amines, amino alcohols, amides, imines, imino acids, nitriles, and nitros.

18. The system of claim 3, wherein at least one polishing additive is both (a) a compound selected from the group consisting of amines, amino alcohols, amides, imines, imino acids, nitriles, and nitros, and (b) a compound selected from the group consisting of thiols, thioesters, and thioethers, carbothiolic acids, carbothionic acids, thiocarboxylic acids, and thiosalicylic acids.

19. The system of claim 17, wherein at least one polishing additive is selected from the group consisting of 2-aminoethyl phosphonic acid, amino(trimethylenephosphonic acid), diethylenetriaminepenta(methylenephosphonic acid), hexamethylenediaminetetra(methylene phosphonic acid), and mixtures thereof.

20. The system of claim 3, wherein the system further comprises a source of ammonia.

21. The system of claim 20, wherein the system comprises (i) aminotri-(methylenephosphonic acid) and (ii) ammonia or an ammonium salt.

22. The system of claim 3, wherein the system further comprises at least one stopping compound.

23. The system of claim 3, wherein the system further comprises at least one polymeric compound that reduces the polishing rate of at least one layer associated with the substrate.

24. The system of claim 3, wherein the system further comprises at least one passivation film-forming agent.

25. The system of claim 3, wherein the abrasive is a metal oxide abrasive.

26. The system of claim 25, wherein the abrasive is selected from the group consisting of alumina, ceria, germania, silica, titania, zirconia, and coformed products thereof, and mixtures thereof.

27. The system of claim 26, wherein the abrasive is alumina.

28. A method of polishing a substrate comprising contacting a surface of a substrate with the system of claim 3 and polishing at least a portion of the substrate therewith.

29. A method of polishing a substrate comprising contacting a surface of a substrate with the system of claim 22 and polishing at least a portion of the substrate therewith.

30. A method for polishing one or more layers of a multi-layer substrate that includes a first metal layer and a second layer comprising the steps of:

(a) contacting the first metal layer with the system of claim 3, and

(b) polishing the first metal layer with the system until at least a portion of the first metal layer is removed from the substrate.

31. A method for polishing one or more layers of a multi-layer substrate that includes a first metal layer and a second layer comprising the steps of:

(a) contacting the first metal layer with the system of claim 22, and

(b) polishing the first metal layer with the system until at least a portion of the first metal layer is removed from the substrate.

32. The system of claim 1, wherein at least one polishing additive is iminodiacetic acid.

33. The system of claim 32, wherein the system further comprises at least one stopping compound.

34. The system of claim 32, wherein the system further comprises at least one polymeric compound that reduces the polishing rate of at least one layer associated with the substrate.

35. The system of claim 22, wherein the system further comprises ammonia or an ammonium salt.

36. A method of polishing one or more layers of a multi-layer substrate that includes a first noble metal layer and a second layer comprising:

(i) contacting the substrate with a chemical-mechanical polishing system comprising:

(a) a liquid carrier,

(b) at least one oxidizing agent,

(c) at least one polishing additive that increases the rate at which the system polishes the noble metal layer of the substrate, wherein the polishing additive is selected from the group consisting of carboxylates and acids thereof, hydroxylates and acids thereof, carbonylates and acids thereof, pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, amines, amino alcohols, amides, imines, imino acids and salts thereof, nitriles, nitros, thiols, thioesters, thioethers, carbothiolic acids and salts thereof, carbothionic acids and salts thereof, thiocarboxylic acids and salts thereof, sulfonic acids and salts thereof, thiosalicylic acids and salts thereof, and mixtures thereof, and

(d) a polishing pad and/or an abrasive, and

(ii) abrading at least a portion of the substrate to polish the substrate.

37. The method of claim 36, wherein the oxidizing agent is a per-compound.

38. The method of claim 36, wherein the noble metal is platinum, iridium, or ruthenium.

39. The method of claim 38, wherein the polishing additive is selected from the group consisting of oxalate salts, pyrophosphate salts, aminotri(methylenephosphonic acid), 1-diphosphonic acid, diethylenetriaminepenta(methylenephosphonic acid), amino acids, and thiodiacetic acid.